

REMARKS

Claims 1-23 are pending in the present Application. Claims 1 and 21 have been amended, and claim 24 has been added, leaving claims 1-24 for consideration upon entry of the present Amendment.

Amendments to Claims

Claim 1 has been amended to claim a polymer having a composition comprising 40-55% wt% of aromatic vinyl units, 0-5.0 wt% of unsaturated dicarboxylic anhydride units, and 40-60 wt% of the imidized units from unsaturated dicarboxylic anhydride units. Support for this Amendment can be found at least in the Specification as originally filed on p. 4, lines 16-20 and p. 6, line 24 to p. 7, line 2.

Claim 1 has also been amended to include the molar ratio of aromatic vinyl monomers to dicarboxylic acid anhydride monomers of 0.63-6:1. Support for this amendment can be found in the Specification at least on page 8, line 7 and page 9, line 14 (from the molar ratios of aromatic vinyl monomer, e.g., styrene, to dicarboxylic anhydride monomer e.g., maleic anhydride after weight to mole conversion based on the maximum and minimum weights of aromatic vinyl monomer and dicarboxylic anhydride monomer.), and in the Examples 1-5.

Claim 1 has further been amended to claim a polymerization residence time of 2.0 to 5.0 hours. Support for this amendment can be found at least in Claim 21, the relevant portions of which have been deleted.

No new matter has been introduced by these amendments.

New Claims

Claim 24 has been added to further claim the invention. Antecedent basis for claim 24 can be found at least in the Examples, and in particular in Examples 4 and 5, where the resulting molecular weights (Mw) are found in Tables 2 and 3 on pages 33 and 34 of the Specification as originally filed. No new matter has been introduced by this amendment.

Reconsideration and allowance of the claims are respectfully requested in view of the above amendments and the following remarks.

Claim Rejections Under 35 U.S.C. § 103(a)

Claims 1-3, 5-8, 10, 12-13, and 23 stand rejected under 35 U.S.C. §103(a) as being unpatentable over JP publication 06-056921 ("Oshida"), in combination with JP publication 2001-329021 ("Kurokawa").

In addition, Claims 1, 4, 9, 11, and 14-24 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Kurokawa in combination with Oshida.

Applicants respectfully traverse both of these rejections, and as the cited art is identical in both sets of rejections, Applicants respond to both rejections simultaneously hereinbelow.

Oshida discloses a method of imidizing a styrene-maleic anhydride copolymer to provide improved impact resistance by kneading the copolymer at a shear rate of greater than 10 sec^{-1} in the presence of an imidization agent, at a temperature of 200-270°C. ¶¶ [0004]-[0005]. The precursor copolymer comprises 60-90 wt% of aromatic vinyl monomer and 10-40 wt% of unsaturated dicarboxylic anhydride. ¶ [0009]. The imidization agent can be a primary or secondary amine, or ammonia, and may be introduced into the imidization reaction as a gas, aqueous solution, or other solution. ¶ [0010-[0012]. Decomposition of the copolymer is avoided by the low shear rate of the kneading. ¶ [0015]. Low molecular weight contaminants can be removed during the kneading (i.e., melt-volatilization extrusion) by applying vacuum to 50-200 torr. ¶ [0017]. Preparation of an exemplary styrene-maleic anhydride copolymer was carried out by polymerizing styrene, methyl methacrylate, an initiator, and maleic anhydride in MIBK in a continuous polymerization reactor to a conversion of 65% at a temperature of 150°C, at a rate of 2.0 Kg/hr, followed by devolatilization at 200°C/50 torr to separate unreacted monomer and solvent from the polymer. ¶¶ [0021]-[0022].

Kurokawa discloses a multistep method for production of imidized polymer in which 1.) a terpolymer having 45-80 wt% vinyl aromatic monomers, 20-50 wt% of dicarboxylic acid anhydride monomer and 0-30 wt% of other vinyl monomers is polymerized in a multistage continuous polymerization apparatus at 60-200°C in a ketone solvent, to a conversion of 95% or greater of monomer; 2.) an amine is added continuously to convert 70 mol% or more of the (polymerized) dicarboxylic acid anhydride monomer to imide; and 3.) continuous

devolatilization of the imidized polymer under reduced pressure and at a temperature of 180-330°C. ¶ [0005]. Homogeneity in the terpolymer prior to imidization is maintained by feeding the dicarboxylic acid anhydride according to its “quantitative ratio”. ¶ [0006]. Less than 45 wt% of the vinylaromatic monomer in the terpolymer results in defects in mechanical characteristics, dimensional stability, and color tone. ¶ [0009].

For an obviousness rejection to be proper, the Examiner is expected to meet the burden of establishing a *prima facie* case of obviousness, i.e., that all elements of the invention are disclosed in the prior art; that the prior art relied upon, coupled with knowledge generally available in the art at the time of the invention, contain some suggestion or incentive that would have motivated the skilled artisan to modify a reference or combined references. *In re Fine*, 5 U.S.P.Q.2d 1596, 1598 (Fed. Cir. 1988); *In Re Wilson*, 165 U.S.P.Q. 494, 496 (C.C.P.A. 1970). As explained in detail below, because the amended claims teach compositions that differ from that taught in the combinations of cited prior art references, obviousness is respectfully traversed.

Claim 1 claims a method for producing an imide-substituted polymer that has excellent heat resistance, and, in particular, where its heat resistance is maximized by preventing the formation of polystyrenes. As specifically claimed in Claim 22, the amount of polystyrene that remains in the imide-substituted polymer prepared by the method of Claim 1 is less than 3% by weight polystyrene homopolymer. Neither Oshida nor Kurokawa teaches or discloses this limitation. As disclosed in the instant Specification, the presence of polystyrenes causes reduction of heat resistance, which can be seen by a comparison of the results of Example 1 to those of Comparative Examples 2 and 3 (p. 33-34, Tables 1 and 2). Also in the Specification, it is noted that the lower residual polystyrene content of the polymer prepared in Example 1 provides superior heat resistance when compared to the material of the Comparative Examples with a higher polystyrene content. See Specification p. 34, lines 2-6.

High heat resistance is illustrated by the high glass transition temperature of the products of the Examples, up to 191.5°C, which is superior to the products of the Comparative Examples, which ranged from 164.5°C to 177.8°C, where the compositions of the Examples, as reported in Table 1 (44.1-54.5 wt% of aromatic vinyl units, 0-1.3 wt% unsaturated dicarboxylic anhydride units, and 44.6-54.9 wt% imidized units), were in accord with Claim

1. See Specification, p. 34. Oshida and Kurokawa are each silent as to the glass transition temperature of the polymers produced by their respective methods, and the combination thus also does not teach or disclose this.

The composition ratio of the imide-substituted polymer prepared by the present invention is optimized for heat resistance, as illustrated by the discussion of the Examples, in particular Examples 2 to 4. See Specification, p. 35, line 21. Accordingly, claim 1, amended herewith to claim a polymer having a composition comprising 40-55% wt% of aromatic vinyl units, 0-5.0 wt% of unsaturated dicarboxylic anhydride units, and 40-60 wt% of the imidized units from unsaturated dicarboxylic anhydride units, and as produced by the method of claim 1, has excellent heat resistance.

While Oshida discloses starting concentrations of aromatic vinyl monomer (60-90 wt%) and of unsaturated dicarboxylic anhydride (10-40 wt%) that is fed into the continuous copolymerization reactor, Oshida is silent as to the composition ranges of vinyl monomers and imidized monomers in the imidized polymer after polymerization and imidization. Oshida, ¶ [0009]. In addition, while Kurokawa discloses starting concentrations of aromatic vinyl monomer (45-80 wt%) and of unsaturated dicarboxylic anhydride (20-50 wt%) that is fed into the continuous copolymerization reactor, Kurokawa is also silent as to the composition range of vinyl monomers and imidized monomers present in the imidized polymer after polymerization and imidization. Kurokawa, ¶ [0005]. and therefore do not make the instant claim unpatentable.

In addition, neither Kurokawa nor Oshida discloses the ratio of aromatic vinyl monomer to unsaturated dicarboxylic anhydride monomer as claimed in instant Claim 1 as amended. After the separation step of Claim 1, only un-reacted monomers are separated, and any polystyrene formed cannot be separated. Thus, the proportion of monomers reacted in the copolymerization step is instrumental in preventing the formation of polystyrene homopolymer. Amended Claim 1 includes a molar ratio of aromatic vinyl monomers to unsaturated dicarboxylic anhydride monomers of 0.67-6.0:1, as polymerized. Neither Oshida nor Kurokawa discloses this. Also as disclosed in the instant specification, 20 to 60 wt% of aromatic vinyl monomers and 10 to 30 wt% of unsaturated dicarboxylic acid anhydride monomers (based on the total weight of monomer, initiator, chain transfer agent, and solvent)

are included in the copolymerization step. See Specification, page 8, line 7 and page 9, line 14. Thus neither Oshida nor Kurokawa disclose this element of instant Claim 1, and therefore do not render this claim unpatentable.

Further, since the reactivity of the aromatic vinyl monomers and unsaturated dicarboxylic anhydride monomers are different, the presence of the less reactive or excess monomers late in the copolymerization step is also a primary factor in preventing the formation of polystyrene homopolymer. By using a relatively short (2.0-5.0 hour) reaction time in the copolymerization step as disclosed, polystyrene formation, which occurs after the unsaturated dicarboxylic anhydride monomers having higher reactivity relative to the aromatic vinyl monomer are fully consumed, can thereby be prevented in advance. Accordingly, amendment of claim 1 to claim the residence time in the copolymerization step of 2.0 to 5.0 hours, can maximize the heat resistance by minimizing production of undesired polystyrene side product as well as minimizing reaction time. Claim 1 is therefore distinguished from Oshida which teaches an exemplary throughput in the continuous feed polymerization of 2.0 Kg/h, but fails to teach a total reaction residence time. Kurokawa is also silent as to the total residence time of the monomers being polymerized. Thus, neither Kurokawa nor Oshida, in any combination, disclose this element of the instant claims, nor does the combination provide a teaching or suggestion that would motivate one skilled in the art to modify the combination of Oshida and Kurokawa to limit the total polymerization residence time to 2.0 to 5.0 hours. Thus, the combinations of Oshida and Kurokawa neither teach all elements of the instant claims or provide a suggestion or incentive that would motivate one skilled in the art to combine the references to provide the invention as claimed in instant Claim 1, and cannot therefore make the instant claim 1 unpatentable.

It is believed that the foregoing amendments and remarks fully comply with the Office Action and that the claims herein should now be allowable to Applicants. Accordingly, reconsideration and allowance are requested.

If there are any additional charges with respect to this Amendment or otherwise,
please charge them to Deposit Account No. 06-1130.

Respectfully submitted,

CANTOR COLBURN LLP

By: /Dana A. Gronbeck/
Dana A. Gronbeck
Registration No. 55,226
Confirmation No. 9045
Cantor Colburn LLP
55 Griffin Road South
Bloomfield, CT 06002
Telephone: (860) 286-2929
Fax: (860) 286-0115

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